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Monsanto

Monsanto Company
Corporate Engineering Department
Sauget, Illinois 62201

October 7, 1985
MC/JSA Letter #9

J.S. Alberici Construction Co.
W. C. Koester

Subject: CEA 3808 South Trunk Sewer
Manhole Finish & Acceptance

Reference: JSA Letter CRL to RM dated August 20, 1985

Tolerances for cast-in-place manhole surfaces are to conform to ACI 347 - stated in the contract specifications. Inspection shall include conforming to paragraph 3.3.8 "Tolerances for formed surfaces cast-in-place". Irregularity allowances shall follow type "C" class of surface to be within ½" gradual and ¼" abrupt when checked with a 5 foot template.

Please correct any deficiencies found to exist outside of the specifications.

B.W. Steketee
Site Construction Manager

BWS/acg

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3.2.9—Use specified size and capacity of form ties or clamps.

3.2.10 — Forms should be inspected and checked before the reinforcing steel is placed to insure that the dimensions and the location of the concrete members will conform to the drawings.

3.2.11—Form coatings must be applied before placing of reinforcing steel and must not be used in such quantities as to run onto bars or concrete construction joints.

3.2.12—Forms should be sufficiently tight to prevent loss of mortar from the concrete.

3.2.13—Forms should be thoroughly cleaned of all dirt, mortar, and foreign matter and coated with a release agent before each use. Where the bottom of the form is inaccessible from within, access panels should be provided to permit thorough removal of extraneous material before placing concrete. If surface appearance is important, forms should not be reused after damage from previous use has reached the state of possible impairment to concrete surfaces.

3.2.14—Control joints, construction joints, and expansion joints should be installed as specified.

3.2.15—Blockouts, inserts, and embedded items should be properly identified, positioned, and secured.

3.3—Suggested tolerances

Tolerance is a specified permissible variation from lines, grades, or dimensions given in contract drawings.

Tolerances should be specified by the engineer/architect so that the contractor will know precisely what is required and can design and maintain his formwork accordingly. The suggested tolerances herein are similar to those specified on important work or major structures by many public agencies and private firms.* In specifying these tolerances or some modifications of them, it should be remembered that specifying tolerances more exacting than needed may increase construction costs.

Contractors are expected, and should be required, to establish and maintain in an undisturbed condition until final completion and acceptance of a project, control points, and bench marks adequate for their own use and for reference to establish tolerances. (This requirement may become even more important for the contractor's protection when tolerances are not specified or shown.) The engineer/ architect should specify tolerances or require performance within generally accepted limits. Where a project involves particular features sensitive to the cumulative effect of generally accepted tolerances on individual portions, the engineer/architect should anticipate and provide for this effect by setting a cumulative tolerance. Where a particular situation involves several types of generally accepted tolerances, i.e., on the concrete, on location of reinforcement, on fabrication of reinforcement, etc., which become mutually incompatible, the engineer/architect should anticipate the difficulty and specify special tolerances or indicate which controls. The contract specifications should clearly state that a permitted variation in one part of the construction or in one section of the specifications must not be construed as permitting violation of the more stringent requirements for any other part of the construction or in any other such specification section.

The engineer/architect should be responsible for coordinating the tolerances for concrete work with the requirements of other trades whose work adjoins the concrete construction.

This section suggests tolerances that are consistent with modern construction practice considering the effect that permissible deviations will have on the structural action or operational function of the structure. Surface defects such as "blowholes" and "honeycomb" concrete surfaces are defined as "finish defects" and are to be distinguished from tolerances described herein.

Where tolerances are not stated in the specifications or drawings for any individual structure or feature thereof, permissible deviations from established lines, grades, and dimensions are suggested below. The contractor is expected to set and maintain concrete forms so as to insure completed work within the tolerance limits.

No tolerances specified for horizontal or vertical building lines or footings should be construed to permit encroachment beyond the legal boundaries.

3.3.1 *Tolerances for reinforced concrete buildings*†

3.3.1.1 *Variations from the plumb.*

(a) In the lines and surfaces of columns, piers, walls, and in arrises	
In any 10 ft of length	¼ in.
Maximum for entire length	1 in.
(b) For exposed corner columns, control-joint grooves, and other conspicuous lines	
In any 20 ft of length	¼ in.
Maximum for entire length	½ in.

3.3.1.2 *Variation from the level or from the grades indicated on the drawings.*

*Designers employed by federal agencies required to follow Building Research Advisory Board recommendations are advised that the BRAB tolerances on formwork are often more restrictive than those suggested herein.

†Variations from plumb and linear building lines on upper stories of high rise structures (above 100 ft high) are special cases which may require special tolerances.

(a) In slab soffits,* ceilings, beam soffits, and in arrises

In any 10 ft of length	¼ in.
In any bay or in any 20 ft of length	⅜ in.
Maximum for entire length	¾ in.

(b) In exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines

In any bay or in any 20 ft of length	¼ in.
Maximum for entire length	½ in.

3.3.1.3 *Variations of distance between walls, columns, partitions, and beams.*

¼ in. per 10 ft of distance, but not more than ½ in. in any one bay, and not more than 1 in. total variation

3.3.1.4 *Variation of linear building lines from established position in plan.* 1 in.

3.3.1.5 *Variation in the sizes and locations of sleeves, floor openings, and wall openings.*

Minus	¼ in.
Plus	½ in.

3.3.1.6 *Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls.*

Minus	¼ in.
Plus	½ in.

3.3.1.7 *Footings.*

(a) Variation in dimensions in plan

Minus	½ in.
Plus	2 in.† when formed, or plus 3 in. when placed against unformed excavation

(b) Misplacement or eccentricity

2 percent of the footing width in the direction of misplacement but not more than 2 in.†

(c) Reduction in thickness

Minus 5 percent of specified thickness

3.3.1.8 *Variation in steps.*

(a) In a flight of stairs

Rise	⅛ in.
Tread	¼ in.

(b) In consecutive steps

Rise	1/16 in.
Tread	⅛ in.

3.3.2 *Tolerances for concrete canal lining*

3.3.2.1 *Departure from established alignment.*

2 in. on tangents
4 in. on curves

3.3.2.2 *Departure from established profile grade.* 1 in.

3.3.2.3 *Reduction in thickness of lining.*

10 percent of specified thickness: provided, that average thickness is maintained as determined by daily batch volumes

3.3.2.4 *Variation from specified width of section at any height.*

¼ of 1 percent plus 1 in.

3.3.2.5 *Variation from established height of lining.*

½ of 1 percent plus 1 in.

3.3.2.6 *Variations in surfaces.*

Invert ¼ in. in 10 ft
Side slopes ½ in. in 10 ft

3.3.3 *Tolerances for monolithic siphons and culverts*

3.3.3.1 *Departure from established alignment.*	1 in.
3.3.3.2 *Departure from established profile grade.*	1 in.

3.3.3.3 *Variation in thickness.*

At any point: minus 2½ percent or ¼ in., whichever is greater
At any point: plus 5 percent or ½ in., whichever is greater

3.3.3.4 *Variation from inside dimensions.*

½ of 1 percent

3.3.3.5 *Variations in surfaces.*

Inverts ¼ in. in 10 ft
Side slopes ½ in. in 10 ft

3.3.4 *Tolerances for bridges, checks, overchutes, drops, turnouts, inlets, chutes, and similar structures*

3.3.4.1 *Departure from established alignment.*	1 in.
3.3.4.2 *Departure from established grades*	1 in.

3.3.4.3 *Variation from the plumb or the specified batter in the lines and surfaces of columns, piers, walls, and in arrises.*

Exposed, in 10 ft	½ in.
Backfilled, in 10 ft	1 in.

3.3.4.4 *Variation from the level or from the grades indicated on the drawings in slabs, beams, horizontal grooves, and railing offsets.*

Exposed, in 10 ft	½ in.
Backfilled, in 10 ft	1 in.

3.3.4.5 *Variation in cross-sectional dimensions of columns, piers, slabs, walls, beams, and similar parts.*

Minus	¼ in.
Plus	½ in.

3.3.4.6 *Variation in thickness of bridge slabs.*

Minus	⅛ in.
Plus	¼ in.

3.3.4.7 *Footings.* Same as for footings for buildings.

3.3.4.8 *Variation in the sizes and locations of slab and wall openings.*	½ in.

*Variations in slab soffits are to be measured before removal of supporting shores; the contractor is not responsible for variations due to deflection, except when the latter are corroboratory evidence of inferior concrete quality or curing, in which case only the net variation due to deflection can be considered.

†Applies to concrete only, not to reinforcing bars or dowels.

3.3.4.9 *Sills and sidewalls for radial gates and similar watertight joints.*

Variation from the plumb or level
Not greater than ⅛ in. in 10 ft

3.3.5 *Tolerances in mass concrete structures*

3.3.5.1 *Variation of the constructed linear outline from established position in plan.*

In 20 ft	½ in.
In 40 ft	¾ in.

3.3.5.2 *Variations of dimensions to individual structure features from established positions.*

In 80 ft or more	1¼ in.
In buried construction	Twice the above amounts

3.3.5.3 *Variation from the plumb, from the specified batter, or from the curved surfaces of all structures, including the lines and surfaces of columns, walls, piers, buttresses, arch sections, vertical joint grooves, and visible arrises.*

In 10 ft	½ in.
In 20 ft	¾ in.
In 40 ft or more	1¼ in.
In buried construction	Twice the above amounts

3.3.5.4 *Variation from the level or from the grades indicated on the drawings in slab and beam soffits, horizontal joint grooves, and visible arrises.*

In 10 ft	¼ in.
In 30 ft or more	½ in.
In buried construction	Twice the above amounts

3.3.5.5 *Variation in cross-sectional dimensions of columns, beams, buttresses, piers, and similar members.*

Minus	¼ in.
Plus	½ in.

3.3.5.6 *Variation in the thickness of slabs, walls, arch sections, and similar members.*

Minus	¼ in.
Plus	½ in.

3.3.5.7 *Footings for columns, piers, walls, buttresses, and similar members.*

(a) Variation of dimensions in plan

Minus	½ in.
Plus	2 in.*

(b) Misplacement or eccentricity
2 percent of footing width in the direction of misplacement but not more than 2 in.*

(c) Reduction in thickness
5 percent of specified thickness

3.3.5.8 *Sills and side walls for radial gates and similar watertight joints.*

Variation from plumb and level...
....Not greater than ⅛ in. in 10 ft

3.3.6 *Tolerances for concrete tunnel lining and cast-in-place conduits*

3.3.6.1 *Departure from established alignment or from established grade.*

Free-flow tunnels and conduits	1 in.
High velocity tunnels and conduits	½ in.
Railroad tunnels	1 in.

3.3.6.2 *Variation in thickness at any point.*

Tunnel lining	minus 0
Conduits	minus 2½ percent or ¼ in., whichever is greater
Conduits	plus 5 percent or ½ in., whichever is greater

3.3.6.3 *Variations from inside dimensions.*
½ of 1 percent

3.3.7 *Tolerances for vertically slipformed structures up to 600 ft high* (not applicable for liftform; see Section 3.3.1) †

3.3.7.1 Maximum horizontal deviation (translational plus rotational) of any point on the structure with respect to a corresponding point at the base of the structure shall not exceed 1 in. per 50 ft of height above the base, nor 3 in., whichever is smaller. Building cores and shafts slipformed and tying into other adjacent work should meet tolerances shown in Section 3.3.1.1.

3.3.7.2 For circular structures, variations from prescribed diameter or variation from true circular cross section shall be not more than ±1 in. or ± ½ in. per 10 ft of diameter, whichever is larger, but in no case more than ±3 in.

3.3.7.3 Variation from prescribed inside width dimensions for noncircular structures shall not exceed ±½ in. per 10 ft of width, nor ±2 in. total.

3.3.7.4 Variation from prescribed wall thickness, −⅜ in. and +1 in.

3.3.7.5 Top elevation of blockouts, +2 in., minus zero. Bottom elevation of blockout, plus zero inches, and −2 in. Sides of blockouts may vary ±½ in. from specified location, but the opening width must not be less than specified.

3.3.8 *Tolerances for formed surfaces cast-in place* —This section provides a way of quantitatively indicating tolerances for surface variations due to forming quality, but is not intended to apply to surface defects attributable to placing and consolidation deficiencies. Allowable irregularities for the purpose of defining tolerances are designated either abrupt or gradual. Offsets and fins resulting from displaced, mismatched, or misplaced forms, sheathing, or liners or from defects in forming materials are considered abrupt irregularities. Irregularities resulting from warp-

*Applies to concrete dimensions only, not to positioning of vertical reinforcing bars or dowels.

†For silo construction tolerances refer to ACI 313-77, Reference 3-1

TABLE 3.3.8—PERMITTED IRREGULARITIES IN FORMED SURFACES CHECKED WITH A 5 FT TEMPLATE

Type of irregularity	Class of surface			
	A	B	C	D
Gradual	⅛ in.	¼ in.	½ in.	1 in.
Abrupt	⅛ in.	¼ in.	¼ in.	1 in.

ing, unplaneness, and similar uniform variations from planeness or true curvature are considered gradual irregularities.

Gradual irregularities should be checked with a 5-ft template, consisting of a straightedge for plane surfaces or a shaped template for curved or warped surfaces. In measuring irregularities, the straightedge or template may be placed anywhere on the surface in any direction.

Four classes of formed surface are defined in Table 3.3.8. The engineer/architect should indicate which is required for the work he is specifying.

Class A is suggested for surfaces prominently exposed to public view, where appearance is of special importance. Class B is intended for coarse textured concrete formed surfaces intended to receive plaster, stucco, or wainscoting. Class C is a general standard for permanently exposed surfaces where other finishes are not specified. Class D is a minimum quality requirement for surfaces where roughness is not objectionable, usually applied where surfaces will be permanently concealed. Special tolerances may be needed for surfaces continuously exposed to flowing water, drainage or exposure. If those tolerances are different from those given in Table 3.3.8 they should be specified by the engineer/architect.

3.3.9 *Tolerances for precast prestressed concrete individual members*—Forms for this type of construction should be true to size and dimensions shown on plans and should be constructed and protected from warping so that the finished product will be within the limits given below unless otherwise noted on contract drawings and specifications. These tolerances are intended primarily for precast prestressed members produced in the field.

3.3.9.1 *Overall dimensions of members* ..... ±⅛ in. per 10 ft, maximum of ±¾ in.

3.3.9.2 *Cross-sectional dimensions.*

Sections less than 6 in. ..... ±⅛ in.
Sections over 6 in. and less than 18 in. ..... ±3/16 in.
Sections 18 in. to 36 in. ..... ±¼ in.
Sections over 36 in. ..... ±⅜ in.

3.3.9.3 *Deviations from straight line in long sections* Not more than ⅛ in. per 10 ft length

3.3.9.4 *Deviation from specified camber* ±⅛ in. per 10 ft of span

3.3.9.5 *Maximum differential between adjacent units in erected position to be one-half the allowance for deviation from specified camber.*

3.3.10 *Suggested tolerances for precast concrete*—*Forms must be true to size and dimensions of concrete members shown on the plans and be so constructed that the dimensions of the finished product will be within the limits given below at the time of placement of these units in the structure*, unless otherwise noted on engineer/architect drawings. These tolerances are intended primarily for precast members produced in the field.

3.3.10.1 *Overall dimensions of members* ..... ±⅛ in. per 10 ft, maximum of ±¾ in.

3.3.10.2 *Cross-sectional dimensions.*

Sections less than 6 in. ..... ±⅛ in.
Sections over 6 in. and less than 18 in. ..... ±3/16 in.
Sections 18 in. to 36 in. ..... ±¼ in.
Sections over 36 in. ..... ±⅜ in.

3.3.10.3 *Deviations from straight line in long sections.* ..... Not more than ⅛ in. per 10 ft

3.3.10.4 *Deviation from specified camber.* ..... ±1/16 in. per 10 ft of span

3.3.10.5 *Maximum differential between adjacent units in erected position.* ..... ¼ in.

3.4—Shoring and centering

3.4.1 *Shoring*—Shoring must be supported on satisfactory foundations such as spread footings, mudsills, or piling as discussed in Section 2.7.

Shoring resting on intermediate slabs or other construction already in place need not be located directly above shores or reshores below unless thickness of slab and the location of its reinforcement are inadequate to take the reversal of stresses and punching shear. Where the latter conditions are questionable the shoring location should be approved by the engineer/architect.

All members must be straight and true without twists or bends. Special attention should be given to beam and slab, or one-way and two-way joist construction to prevent local overloading when a heavily loaded shore rests on the thin slab.

Multitier shoring assemblies supporting forms for high stories must be set plumb and the separate parts of each shore located in a straight line over each other, with two-way horizontal bracing at each splice in the shore unless the entire assembly is designed as a structural framework or truss. Particular care must also be taken to transfer the horizontal loads to the ground or